A POLICY REVIEW MODULE FOR THE INTERACTIVE HIGHWAY SAFETY DESIGN MODEL

Greg L. Giering[1] and Joe G. Bared, Ph.D., P.E.[2]

Abstract

The Federal Highway Administration's Interactive Highway Safety Design Model, or IHSDM, is a suite of CADD-compatible programs that highway designers can use to evaluate the safety effects of various design alternatives. IHSDM will be composed of five safety analysis modules: the Accident Analysis Module, the Design Consistency Module, the Driver/Vehicle Module, the Traffic Simulation Module, and the Policy Review Module. The focus of this paper is on the conceptual plan, implementation, and intended use of the Policy Review Module (PRM).

The PRM will allow the verification of highway design policies at various steps in the design process. Look-up tables and rules will be used to perform the reviews. A design deficiency can be shown directly within the CADD environment by "flagging" or highlighting the unsatisfactory element, and explaining the policy violated. The user may either correct any deficiency or request a design exception when the constraint cannot be eliminated. If a design deficiency is to be documented, the user could first be prompted to conduct further analyses on the design using other IHSDM modules. A summary of the review will be provided as a text file, listing all elements of the design that did not meet the policy guidelines.

The PRM should include, at a minimum, the capability of verifying that a design meets the American Association of State Highway and Transportation Officials' (AASHTO) policy. It should also accommodate for individual State and/or local agency guidelines. This would entail the provision of a mechanism for each agency to enter its appropriate policies, when they differ from AASHTO.

Introduction

The Interactive Highway Safety Design Model (IHSDM) is a high-priority

[1]Transportation Research Engineer, A/E Group, Inc., c/o FHWA HSR-20,6300 Georgetown Pike, McLean, VA 22101

[2]Research Highway Engineer, Federal Highway Administration HSR-20, 6300 Georgetown Pike McLean, VA 22101

research and development project of the Federal Highway Administration (FHWA). IHSDM is a CADD-compatible safety analysis software for use by highway planners, designers and reviewers. Users will be able to assess the safety impacts of various design decisions on new and reconstruction highway projects, while operating within the civil design software. A full product applicable for two-lane, rural roads is expected to be complete in 2002, with provisions for multilane facilities to follow. IHSDM will ultimately consist of the following five modules:

•Accident Analysis Module (AAM) - will allow for the 1) estimation of the number and severity of accidents, 2) performance of a benefit/cost analysis based on roadside encroachments, and 3) diagnostic reviews of hazardous locations and elements along the proposed roadway, based on an expert systems approach.

•Design Consistency Module (DCM) - will provide information as to the consistency and adherence to driver expectancy of the design, based on operating speed profiles and driver workload measures.

•Driver/Vehicle Module (DVM) - will allow for the simulation of vehicle behavior along the proposed roadway as a function of a variety of AASHTO vehicles driven by drivers with selected characteristics.

•Traffic Simulation Module (TSM) - will provide measures of capacity, delay, and interaction effects between vehicles under realistic traffic flow conditions using existing microsimulation models.

•Policy Review Module (PRM) - will notify designers of particular elements that do not meet the established State, local, or AASHTO design policy.

The focus of this paper is on the function and output of the PRM: how the users may utilize the PRM; what policies are checked; and how the output is displayed. Roadway design data exchange aspects are addressed, using examples from prototypes of other IHSDM modules. Finally, future considerations for the PRM are discussed.

More information on the entire IHSDM can be obtained from reports published by Harwood and Mason, 1994, and Paniati and True, 1996.

<u>Background on the Policy Review Module</u>

FHWA commissioned three consultants to prepare individual white papers on a conceptual plan for the PRM. These three papers by T. Hartzell, E. Hilton and J. M. Mason were reviewed by FHWA staff, and the staff at their Geometric Design Lab. This paper represents the compilation of these efforts into one conceptual plan.

The intended uses for the PRM, and the entire IHSDM, are for highway planning, preliminary and final design, as well as design review, for both new and reconstruction projects. During the planning process, limited information is available concerning the site location and vertical and cross sectional design. Therefore, it is imperative that the PRM can perform checks using only those design elements that are available at this precursory stage. Any text results obtained at this level should be clearly indicated as "Preliminary" to avoid placing too great a credence in the outcome. At the preliminary and final design stages, additional information becomes available to the designer to conduct a more comprehensive policy review. In the design review stage, the PRM should be usable by a project manager who may not be an expert CADD user. The reviewer should be able to ensure that all aspects of design have met the appropriate policies.

The PRM should include quantitative guidelines provided in the American Association of State Highway and Transportation Officials' *A Policy on Geometric Design of Highways and Streets* (AASHTO, 1994), *Roadside Design Guide* (AASHTO, 1989), and *Guide for the Development of Bicycle Facilities* (AASHTO, 1991). It would also provide the user the ability to enter particular State and/or local guidelines when they deviate from AASHTO policy. This can be accomplished through the graphical user interface (GUI), where each table, chart, or figure of design values may be retrieved, edited, saved, and used for subsequent reviews.

The initial version of the PRM should not include qualitative guidelines given in the AASHTO documents, among others. These guidelines can include such items as the assessment of the coordination between horizontal and vertical curvature, and the identification of short tangents between reverse horizontal curves on crest vertical curves. The reason for their omission as a qualitative check is the lack of universally accepted criteria by which each guideline is defined. Until such time when acceptable criteria are established for these qualitative items, they can be assessed quantitatively to see if proper sight distance is provided.

<u>Data Exchange Between the CADD and the Policy Review Module</u>

A prototype PRM will be programmed within the CADD operating environment, similar to other prototype IHSDM modules. Currently there are prototype versions of the DCM and AAM modules that have been successfully linked to the highway geometric design data generated by the civil design software. FHWA is using the GEOPAK™ civil design software operating within the MicroStation™ CADD environment for initial development. However, it is envisioned that IHSDM should be multiplatform in the future (i.e., AutoCAD, and others).

Existing IHSDM prototypes have been developed using the MicroStation Development Language (MDL), a "C" based programming language, containing a library of functions specific to the operation of MicroStation. These functions allow for the formulation of dialog boxes and the access of vector information of MicroStation CADD elements. GEOPAK also allows for the designation of MicroStation vectors as highway geometric elements (i.e., tangents, vertical curve, etc.). Using both GEOPAK and MicroStation functions has been necessary throughout the implementation of the DCM and AAM modules. A comparable development strategy will be used for the PRM.

An example of how these functions could be used to develop the PRM is first to produce a graphical user interface (GUI) using the MDL functions. The GUI should consist of a series of dialog boxes that would allow users to manually enter required data to perform a policy review, select desired review topics, and view results via the computer monitor (Figures 1 - 3). GEOPAK functions would be employed to extract the horizontal, vertical, and cross sectional information. The extracted information would then be saved into a database created specifically for IHSDM data. Once extracted, each element can be compared with the minimum AASHTO, State, or local policy criteria, based on information provided through the input dialog boxes and the look-up tables programmed in the PRM software.

Policy Review Module Operation

The user would begin by invoking the IHSDM dialog box and entering the job number, chain name, profile name, and pavement file, then selecting the PRM module. A PRM top-level dialog box would appear, prompting the user for additional information. The information necessary to run the PRM includes: design speed, functional classification, high- or low-speed design, terrain, design vehicle, maximum superelevation, percent superelevation runoff on tangent, and average daily traffic (ADT). In addition, the user would select the design criteria used for the project (i.e., AASHTO or State standards). An example of the top-level PRM input dialog box is shown in Figure 1.

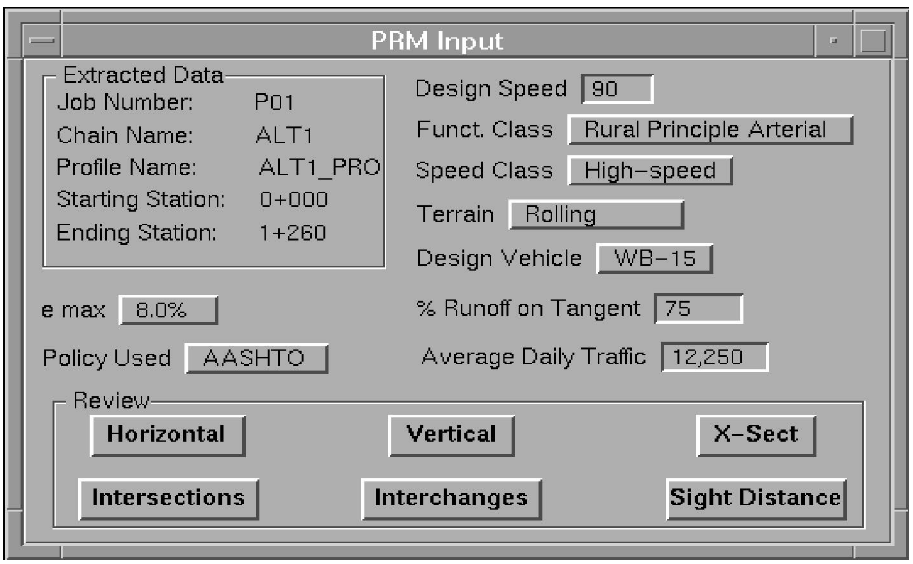

Figure 1 - PRM Top-Level Input Dialog Box

Policy checks performed by the PRM will be grouped into the following categories:

•Horizontal Alignment

•Vertical Alignment

•Cross Section

•Intersections

•Interchanges

•Sight Distance

Two methods of operation are recommended in the PRM: a line-item, or "Review Selected Items" mode; and an "Automatic Review" mode. In the "Review Selected Items" mode the user has the option of selecting particular policy review items to check. For example, the user would begin by manually entering and selecting the required information in the top-level dialog box, and choosing a policy group to be checked (e.g., horizontal alignment). By selecting a policy group to be checked, a second-level dialog box would appear that contains all of the available policy review items for that particular policy group (e.g., radius of curve, superelevation rate, superelevation transition, spiral lengths, etc.)(Figure 2). The user could then check off only those items for which reviews are desired. An entry field could also be provided to specify the text file name where the results are stored.

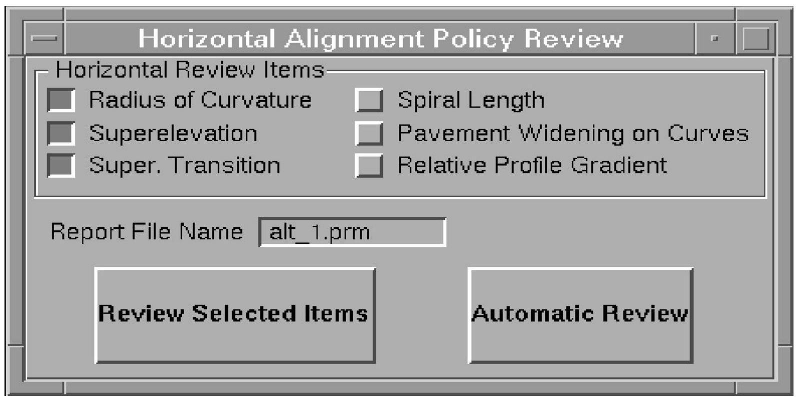

Figure 2 - PRM Horizontal Alignment Policy Review Dialog Box

Once all of the information has been entered in the top-level dialog box, the user can then press the "Review Selected Items" button, as shown in Figure 2. This method of use would be particularly suitable during the initial design phases where only certain policy checks could, or would, be performed due to the paucity of data. Any time the "Review Selected Items" option is chosen, the text report generated should indicate "Preliminary Results," as discussed previously.

The second mode of operation, the "Automatic Review" mode, would be used to scan the design and perform all policy checks within one of the six categories indicated above. This operation is similar to the previous mode with the exception that individual policy items would not be checked-off for review. Use of this method would be more suitable during the final design or design review stage where all the necessary data to perform an entire policy check is available. The text report generated when using this option would not be marked as "Preliminary," so that it may be appropriate for final design review or inclusion in the project documentation.

The following is a list of policy reviews, based on policy grouping, that could be conducted on a two-lane rural road. These items would allow a design to be checked versus ten of the twelve controlling criteria established by FHWA: lane width; shoulder width; bridge width; horizontal alignment; vertical alignment; grades; stopping sight distance; cross slope; superelevation; and vertical clearance.

Horizontal Alignment:

Radius of Curve

Superelevation

Superelevation Transition (Runoff/Runout)
Spiral Length
Relative Profile Gradient
Pavement Widening on Curves
Compound Curve Ratios

Vertical Alignment:
Maximum/Minimum Grades
Critical Length of Grade
Climbing Lanes
Vertical Curve Length (k-value)

Cross Section:
Pavement Cross Slope (Normal Crown)
Lane Widths
Shoulder Widths
Shoulder Cross Slope
Cross Slope Rollover
Roadside Slope (Foreslope/Backslope)
Clear Zone
Bridge Width
Vertical Clearance

Intersections:
Minimum turning radius
Turning Lanes
Channelizing Islands
Intersection Sight Distance

Interchanges:
Ramp Design Speed
Ramp Pavement Width
Ramp Shoulder Width
Speed Change Lane Length
Speed Change Lane Width
Speed Change Lane Taper Length

Sight Distance:
Stopping
Passing
Decision
Intersection

Sight distance was made a separate policy grouping for a few reasons:

1. Sight distance may ultimately be calculated using a three-dimensional model of the roadway design. This method would permit the user to determine if the design meets the policy from an as-built perspective. As such, sight distance is a combination of horizontal, vertical, and cross section geometry, and does not correspond to any one of the other five policy groupings.

2. Calculating sight distance using a three-dimensional model may not be possible. Furthermore, requiring the user to create this model to review sight distance may not be desirable, especially in the earlier design stages. By providing a separate policy grouping, the user can select whether sight distance would be determined based on the two-dimensional plan and profiles, or the three-dimensional model.

3. Provide the user the ability to generate a sight distance profile. This profile could compare the available stopping, decision, passing, or intersection sight distance versus the minimum required by policy. This could be particularly significant at locations where conflicts or driver decisions may be important.

Once a design review is performed, there are multiple ways that the results can be presented to the user. The text file discussed previously would always be generated whenever a review is performed. It should contain all the information manually entered by the user in the top-level dialog box, in addition to other specific information for each project (such as project number, horizontal, and vertical alignments) to distinguish it from other projects. A summary account of which policy was used (i.e., AASHTO, State, or local), and the policy checks that were initiated should also be included. Each policy item checked would be shown, and it should be noted if all elements in the design "passed," and any that "failed."

A "Policy Violation" dialog box (Figure 3) would allow the user to view any deficiencies directly within the CADD software. Following a PRM check, any element that does not meet the selected design policy can be highlighted by using an interactive dialog box. The box shows which element is deficient and the particular policy that was not satisfied. The actual element may be "flagged" or highlighted in the CADD design file in conjunction with this dialog box. Options would be presented to the designer to either a) view the policy that was not met, b) request a design exception, or c) continue identifying any further deficiencies in the design.

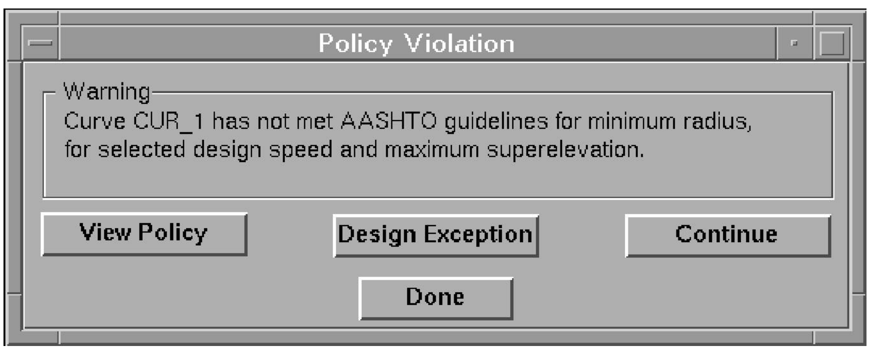

Figure 3 - PRM Policy Violation Dialog Box

If the option selected is to view the policy, the program could link to exhibits, or simulations, describing the specific policy that is not met. For example, for too small a vertical curve length, a diagram or figure could be displayed to demonstrate the concept of vertical curve sight distance and minimum curve length. The easiest way to accomplish this is to have a link to the AASHTO Greenbook on CD-ROM (not yet available).

Another option available will assist the user in requesting a design exception. When the "Design Exception" button is invoked, the PRM could first open a dialog box that would allow for further analysis of the safety implications of the design exception by using the remaining IHSDM modules. After using other IHSDM modules to assess the design, the user could click on "Continue" to bring up a word processing or "notepad" application. An electronic form of a request for a design exception, to be filled out by the user, would be contained herein.

The final option in the "Policy Violation" dialog is for the user to continue checking the rest of the elements in the design before returning to the civil design software to make any desired adjustments. If the design should "pass" all policy checks performed, the user would be informed via a dialog box that no elements were found deficient, and this would also be reflected in the report file generated.

PRM In the Future

The following is a list of items that may be considered for inclusion in the PRM in the future:

•Provisions for exploring each design policy item through queries leading to references that may help in correcting a design deficiency, and may ultimately list potential corrective actions.

•Allow the input of criteria for State guidelines used in resurfacing, restoring, or rehabilitation (3R) projects.

•The input of the mapping accuracy used to generate the design, to allow for computational inaccuracies.

•The capability of manually specifying information that cannot be automatically extracted, such as the stop lines at intersections.

•The use of computerized vehicle turning templates for intersections.

Summary

The Policy Review Module of the Interactive Highway Safety Design Model is intended to serve as a CADD-compatible software solution for highway planners, designers, and reviewer to ensure that new or reconstructed roadway projects have met the appropriate AASHTO, State, or local design policies.

Programming of the PRM will ensue with a contract to be awarded by FHWA during Fiscal Year 1997. Prototype versions of the PRM will then be beta-tested by one or two State Departments of Transportation before full-scale implementation.

Appendix

Roadside Design Guide, Amercian Association of State Highway and Transportation Officials, Washington, D.C., 1988.

Guide for the Development of Bicycle Facilities, Amercian Association of State Highway and Transportation Officials, Washington, D.C., 1991.

A Policy on Geometric Design of Highways and Streets, Amercian Association of State Highway and Transportation Officials, Washington, D.C., 1994.

Harwood, D.W., Mason, J. M., and Graham, J. L. *Conceptual Plan For An Interactive Highway Safety Design Model.* Report FHWA-RD-93-122, FHWA, U.S Department of Transportation, 1994.

Paniati, J. F., and True, J. Interactive Highway Safety Design Model (IHSDM): Designing Highways With Safety In Mind. In *Transportation Research Circular Number 453*, TRB, National Research Council, Washington, D.C., 1996.